Technical Barriers to Emissions Reductions: Gas STAR Case Studies

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Agenda

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- **Technological Barriers to Methane Savings**
- **Oxy's Experience in Methane Recovery**
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  - **Other Potential Opportunities for Methane Recovery**
  - **Strategies to Overcome Technical Barriers**

Oxy's Operations: United States

• Elk Hills	California
• Long Beach (THUMS, Tidelands)	California
• ORCA	California
• Permian	Texas & New Mexico
• Hugoton	Kansas
• Rocky Mountains	Colorado/Wyoming

Top Oil Producer - Texas
Top Gas Producer - California

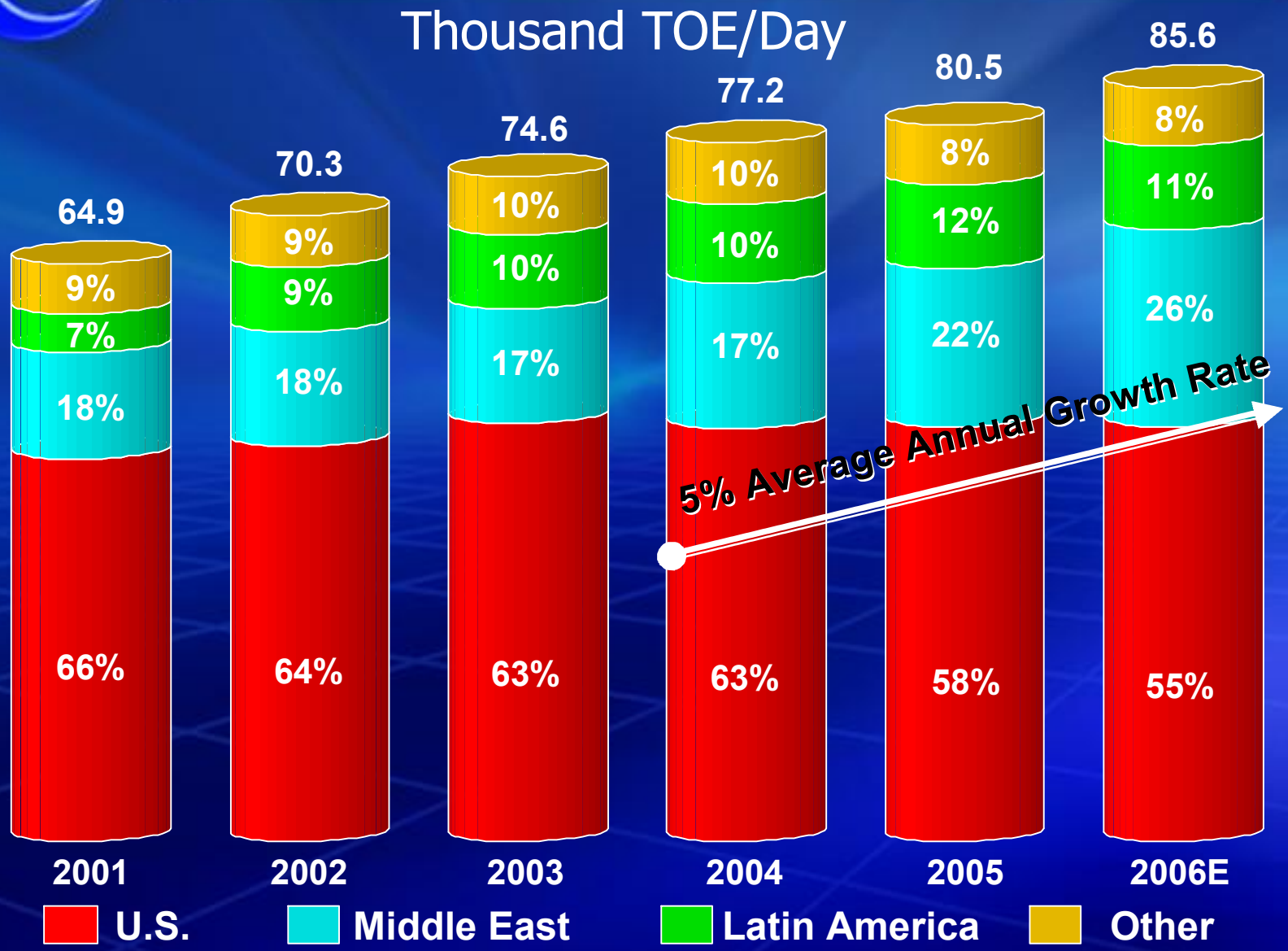
Oxy's Operations: International

- **Argentina ***
- **Bolivia ****
- **Colombia ***
- **Libya ****
- **Oman ****
- **Pakistan**
- **Qatar ****
- **Russia ***
- **Yemen ****

* Methane-to-Markets Partner Country

** It is possible to work with Gas STAR International, under Methane to Markets, in all of the above countries

Oil & Gas Production



Oxy's Participation and Accomplishments in NGS/M2M

- Oxy joined NGS in 2004
- Oxy's operations demonstrated over **230 million m^3** of methane emission reductions in its US assets
- Oxy recognized tremendous opportunities and application of the Methane-to-Markets initiative in its international assets
- Oxy sponsored the first international Latin American Methane-to-Markets Workshop in Bogotá, Colombia: 2005
- Oxy was awarded the International Partner of the Year 2005
- Oxy is committed to finding and using **cost-effective** methane emission reduction technologies and engineering methods

Methane Emitting Sources: Oil & Gas Exploration and Production Sector

- Oxy's international operations focus on reducing methane emissions from major sources

Estimated 2005 CH_4 Emissions from Oil and Gas Industries*

Argentina	1,058 million m^3
Bolivia	164 million m^3
Colombia	264 million m^3
Pakistan	441 million m^3
United States	8,934 million m^3

Exploration and Production Sources	Contribution to Total CH_4 Emissions from Oil and Gas Industries
Pneumatic Devices	17%
Dehydrators and Pumps	5%
Gas Engine Exhaust	3%
Storage Tanks Venting	2%

* EPA. "Global Anthropogenic Emissions of Non-CO_2 Greenhouse Gases 1990-2020 ." June 2006

Technical Barriers to Methane Savings

- Lack of familiarity, benefits, and options of technologies
- Lack of readily available measurement techniques and instruments (especially in some international locations)
- Lack of outlet for recovered gas
  - Spare compression capacity to boost gas to pipeline pressure
  - On-site fuel use
  - Gas processing plant in the vicinity to recover gas liquids

Technical Barriers to Methane Savings

- Lack of resources available for recovery
  - Electricity or fuel
  - High pressure gas
  - Produced water
- Perceived or short-term high capital costs of recovery technologies

Oxy's Experience: US and International Operations

TECHNOLOGIES	COUNTRIES APPLIED
Vapor Recovery Units (VRUs)	US, Qatar (Colombia, Argentina)
Storage Tank Removal and Consolidation	US, Colombia, Argentina
Applying Protective Tank Coating	US, Oman, (Argentina)
Converting IC engines to electric	US, Argentina
Upgrading Compressor Packing	US
Connecting Process Safety Values (PSVs) to Flare	US, Oman, Qatar, Colombia
Fugitive Monitoring Programs	US
Installation of Non-Selective Catalytic Reduction (NSCR) control	US, Qatar, (Argentina, Colombia)

Highlights of Oxy's US and International Experience

- **US Experience**:
  - Vapor Recovery Unit (VRUs) at Wasson Tank Battery (CDU 1 & 2), Denver City, Texas
- **Argentina Experience**:
  - Converting Wellhead IC Engines with Electric Motor Drives
  - Storage Tank Consolidation
- **Oman Experience:**
  - Protective Coating on Storage Tanks
- **Colombia: (Proposed Project)**
  - "Vapor Jet" water eductor vapor recovery unit (VRU) rather than a conventional compressor VRU.

Oxy's US Experience: VRUs

Oxy Case Study - Vapor Recovery
Wasson Tank Battery (CDU 1 & 2)
Denver City, Texas
Installed in 2004

- Oxy purchased two vapor recovery units in August 2004 for capturing vapors from two separate tank batteries at our Wasson facility.
- Each battery produces approximately 12,750 m^3/day of tank vapors, which Oxy needed to gather and compress into a 45 psig sales line.
- Due to the low discharge pressure, Oxy selected rotary vane compressor packages capable of moving 14,000 m^3/day.
- In order to minimize maintenance, Oxy selected electric drive units (55 kW electric motors on each unit).

Oxy Wasson Tank Batteries

Oxy US Experience: VRUs

	Each Unit	Total
Purchase Cost	$92,500	$185,000
Installation Cost	$9,500	$19,000
Installed Cost	$102,000	$204,000
Gas Volume (m^3/day)	12,750	25,500
Value @ \$0.21/m^3 (\$6/mcf)	$2,700	$5,400
Annual Revenue*	$985,500	$1,971,000
Monthly Incr. Revenue	$82,125	$164,250
Payout (in Months)	1.24	1.24

* No heat content adjustment and no liquid sales

** All costs and revenue in US$

Oxy's Argentina Experience:

Converting Gas-Fired Wellhead IC Engines to Electric Motor Drives:

	Each Unit	Total (40 Units)
Methane Reduction (average):	0.6 tonnes/yr	24.8 tonnes/yr
Reduced Fuels use (average):	127,425 m^3	5,097,032 m^3
Revenue from Reduced Fuel use*:	$22,500/yr	$900,000/yr
Reduced Maintenance (average):	$4,050/yr	$162,000/yr
Electric Power Cost ($0.025/KWh):	$3,185/yr	$127,350/yr
Electric Motor Replacement Costs:	$18,300	$732,000
Savings:	$23,400/yr	$936,000/yr
Pay Back Time:	<10 Months	

* All costs and revenue in US$

Oxy's Argentina Experience:

Petroleum Storage Tank Removal and Consolidation:

No. of Storage Tanks being removed:	26
Total Storage Capacity being removed:	81,000 tonnes
Total methane emissions reduced:	105,000 m^3/yr
Cumulative methane emission reduction over 6 years:	630,000 m^3/yr
Gas sales revenue*:	$ 18,500/yr
Cumulative gas sales revenue over 6 years:	$ 110,000
Estimated total cost of tanks removal:	$ 105,000
Payback period:	< 6 yrs.

* All costs and revenue in US$

Oxy's Oman Experience

Protective Storage Tank Coating:

No. of tanks with Protective Coating:	20
Estimated Methane fugitive leak:	3,200 m^3/yr
Revenue from sale of recovered gas*:	$ 684/yr
Cost of coat application:	$ 3,000
Payback period:	< 5 yrs

* All costs and revenue in US$

Oxy Experience: Colombia

Proposed Project with US EPA Guidance:

Preliminary Project Analysis for “VaporJet" water eductor vapor recovery units (VRUs) for power generation:

- No. of VRUs*: 8
- Installation and Capital cost**: $ 130,000 – 150,000
- O & M cost: $ 20,000 – 25,000/yr
- Gas Recovery: 32,285 m^3/day
- Value of recovered gas: $ 600,000–650,000/yr
- Payback period: < 5 months
- Recovered gas may be used to generate electricity on-site to back out purchased electricity and offset rising energy costs.

* Three 5,700 m^3/day VRUs and five 14,200 m^3/day VRUs; ** All costs in US$

Other Opportunities

- Colombia:
  - Proposed VRU Project: Most likely in 2007
- Argentina:
  - Tank consolidation: 2006 to 2010
  - VRUs or other techniques to recover and compress 70,000 m^3/day for pipeline sale: 2006/07
- Qatar:
  - 30 to 40% flaring already eliminated
  - Flare elimination by 2009
  - Gas recovered and sent via pipeline
- Oman:
  - Invested US$120–150 million for gas recovery and compression from our Safah field and send gas via Oman Gas to UAE

Strategies To Overcome Technical Barriers

- Adopt a phased approach:
  - Identify sources existing and potential
  - Measure, estimate, and monitor emissions
  - Identify and evaluate readily available and usable technologies
  - Evaluate alternate technological options
  - Conduct project feasibility analysis and create business case
- Harvest the low hanging fruits
- Review and carefully evaluate readily available PROs (Partner Reported Opportunities) and experiences; wealth of information with US EPA
- Integrate the program as part of project planning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